

NIST Renews Benchmark SRMs for Accurate Determinations of Trace Elements in Serum and Liver

NIST is redeploying exhausted supplies of Standard Reference Materials (SRMs) needed by The Centers for Disease Control and Prevention (CDC), who collects data on elemental composition of human body fluids and tissues as part of major studies such as the National Health and Nutrition Examination Survey (NHANES). These studies require the analysis of large numbers of samples obtained from study subjects. The new SRMs will help assure the accuracy of the analytical data.

R. Zeisler, S.J. Christopher, S.E. Long, E.A. Mackey, K.E. Murphy, and R.O. Spatz (Div. 839)

NIST supports clinical trace element measurements with several benchmark SRMs. Supplies of two of these materials, SRM 1598 Bovine Serum and SRM 1577b Bovine Liver have been exhausted and the replacement materials, SRM 1598a Animal Serum and SRM 1577c Bovine Liver, are being issued. Certified or reference values are provided for all of CDC's priority elements in these materials.

Units of SRM 1598a have been prepared from a serum pool derived from a mixture of serum from healthy bovine and porcine animals. Sera were collected under strict protocols designed to preserve the original composition and to minimize contamination. Briefly, the blood was obtained directly from an incision of the carotid artery and was collected in clean polyethylene pails. It was then immediately (before clotting) distributed among clean polyethylene bottles for further preparation in a clean room facility. After clotting, serum was obtained by centrifugation. These samples were stored at 4 °C. To prepare individual units of SRM 1598a, the serum was then pooled and 5 mL aliquots were dispensed into pre-cleaned polypropylene tubes, which were capped and frozen at -80 °C.

NIST's two new SRMs have an expanded list of elements certified at naturally occurring levels. These valuable resources establish a benchmark for measurement of critical elements in human and animal body fluids and tissues.

For elemental certification in SRM 1598a, NIST values for Cd and Ni were obtained with isotope dilution mass spectrometry (IDMS); all other elements were determined with at least one method carried out at NIST: instrumental neutron activation analysis (INAA), neutron activation analysis with pre-concentration of selected elements on Chelex 100 columns (PNAA), and inductively coupled plasma mass spectrometry (ICP-MS). Results from these measurements were combined with data provided by collaborating research and clinical laboratories using graphite furnace atomic absorption spectrometry, isotope dilution gas chromatography – mass spectrometry, ICP-MS, ICP atomic emission spectrometry (ICP-AES), INAA, and neutron activation analysis with radiochemical separations (RNAA). The CDC priority elements for which certified values are provided are shown in [Table 1](#).

Al	2.3	±	0.6
Cr	0.33	±	0.08
Cu	1580	±	90
Mn	1.78	±	0.33
Ni	0.94	±	0.18
Se	134.4	±	5.8
V	1.88	±	0.11
Zn	880	±	24

Table 1. Certified values (µg/L) and expanded uncertainties for CDC priority elements in SRM 1598a. (Ni and V were not certified in SRM 1598.)

For SRM 1577c, liver tissue was collected from 31 steers that were slaughtered at Texas A&M University School of



Veterinary Medicine. The animals were slaughtered for the purpose of teaching students bovine anatomy and how to butcher. The meat from these animals was prepared for retail under the supervision of a State

of Texas meat inspector to ascertain the health of the animals. Each liver was rinsed with HPLC-grade water to remove excess blood, bile, and any other extraneous material. Fresh tissue (120 kg) was harvested from this process, frozen in clean Teflon bags, and shipped to NIST. The tissue was homogenized at NIST with a food processor equipped with titanium blades. The resulting paste was poured into glass trays, frozen, and lyophilized. The dry material was blended in a food processor and then

jet-milled. The resulting final product was radiation sterilized and bottled in 20 g units. Initial analyses by INAA established homogeneity of selected minerals and trace elements in the SRM. Analysis for value assignment will involve INAA, IDMS, ICP-MS, and ICP-AES at

Future Plans: Extension of measurements to the determination of metalloproteins and other metal-containing moieties is foreseen. It is becoming more important to characterize many elements at levels much lower than previously observed. New and improved analytical procedures must be employed to measure contamination-free levels of ultra-trace elements.

NIST with cooperating laboratories contributing results from GFAAS, ICP-MS, and INAA measurements with the aim to certify all CDC priority elements, a number of Environmental Protection Agency priority elements, and other minerals and trace elements.